

Solutions

Physics 1403-002 Exam #2 sample questions

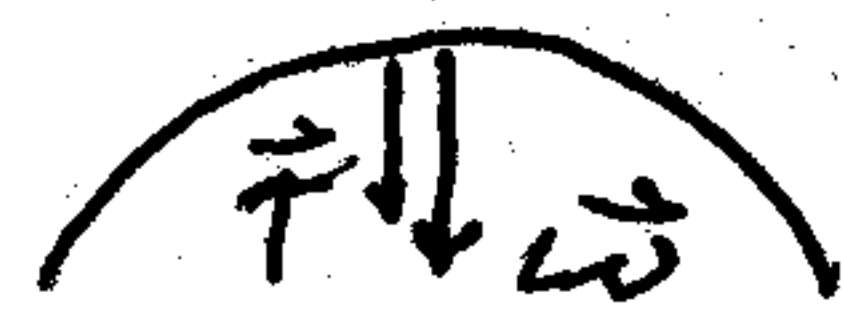
Instructions: Do real good. Show your work for all problems. Partial credit will be assigned for things that make sense.

Short questions:

1. A mass on a string moves on a vertical circle of radius 5.5 m. At what speed must it move at the top of its path for the string tension to be 15% of the weight of the mass?

Total inward force = centripetal force

$$mg + T = \frac{mv^2}{R} \quad T = \frac{mv^2}{R} - mg = 0.15mg$$
$$\frac{v^2}{R} = 1.15g \quad v = \sqrt{1.15gR} = 7.87 \text{ m/s}$$

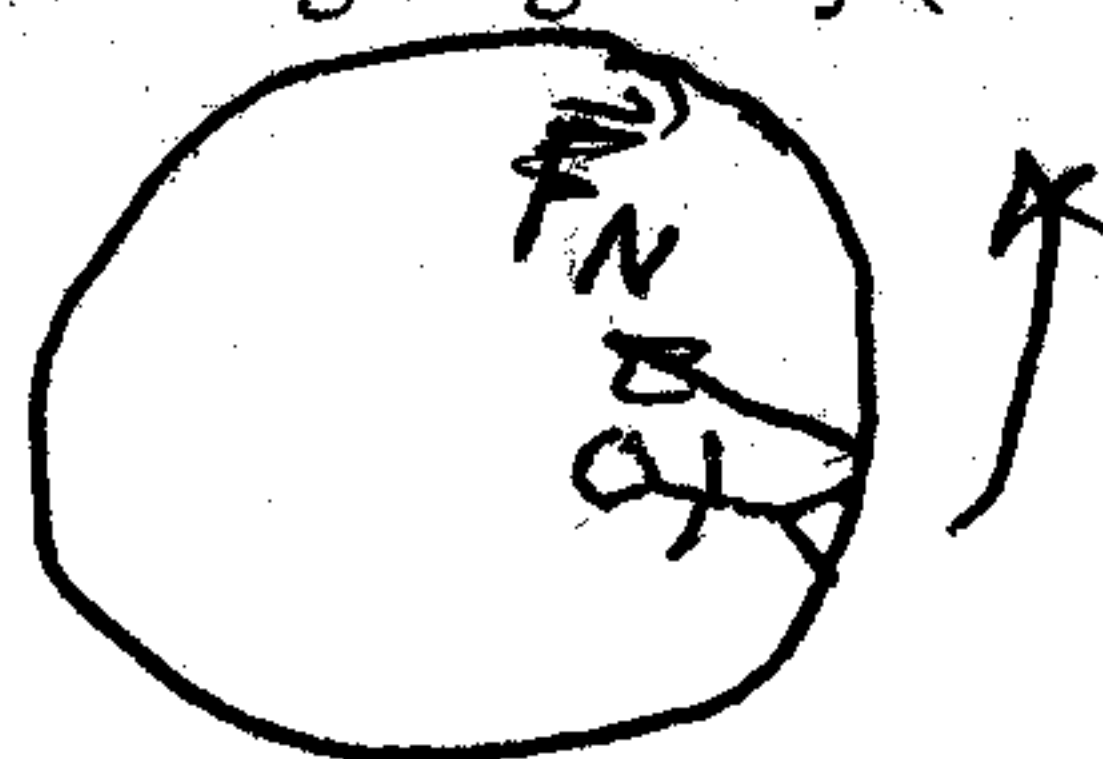


2. A 0.050 kg rabbit is swung on a 3.5 m long string in a horizontal circular path. If the period of the rabbit's motion is 1.20 s, find the centripetal force on the rabbit.

$$T = \frac{2\pi R}{v} \quad v = \frac{2\pi R}{T} = 18.3 \text{ m/s}$$
$$F_c = \frac{mv^2}{R} = \frac{(0.050 \text{ kg})(18.3 \text{ m/s})^2}{3.5 \text{ m}} = 4.8 \text{ N}$$

3. An astronaut in space can be given the sensation of gravity by being in a rotating cylinder. What is the real (not fictitious) force that provides the feeling of gravity (I do not want you to answer, "the centripetal force")?

The normal force



4. A 1200 kg elevator's cable snaps and it falls freely until its speed is 15 m/s. Then emergency brakes kick in and stop the elevator. The elevator drops a distance of 20 m while it is being slowed. How much work did the brakes have to do to stop the elevator?

$$W_{\text{fric}} = \Delta E_{\text{mech}} = \Delta K + \Delta U$$
$$= K_f - K_i + U_f - U_i = -\frac{1}{2}(1200 \text{ kg})(15 \text{ m/s})^2 - (1200 \text{ kg})(9.8 \text{ m/s}^2)(20 \text{ m})$$
$$W_{\text{fric}} = -135 \text{ kJ} - 235 \text{ kJ} = -370 \text{ kJ}$$

5. If I stand on a highway overpass and throw rocks I will be arrested. But before that, I throw rock #1 outwards and upwards, rock #2 horizontally, and rock #3 downwards and outwards, all at the same initial speed. Which rock has a higher speed when it hits the road, and why?

They all have the same final speed

$$\Delta K = -\Delta U = +mgh, \quad h \text{ is the same, so } \Delta K$$

and v_f are the same

6. 25,000 kg/s of water falls over a 32 m high dam wall. How much power is generated?

$$\Delta U \text{ per second} = (25,000 \text{ kg/s})gh = 7.84 \times 10^6 \text{ J/s}$$
$$= -\Delta K / s \Rightarrow \text{Power}$$
$$P = 7.84 \times 10^6 \text{ W}$$